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Ion-Beam Laboratory

Resource for materials development and processing

LLNL's Ion-Beam Laboratory has the advanced facilities and expertise to modify and characterize many different materials in an efficient and timely manner.

Ion implantation and irradiation

Modification processes at the Ion-Beam Laboratory include (1) ion implantations of atoms inside the surfaces of materials to create compound and alloy layers and low-concentration doping (i.e., for diffusion studies and calibration standards), and (2) ion irradiations for improving the adhesion of thin films, changing the stress state of surfaces and thin-film structures, and studying radiation damage.

Ions are implanted in both processes. In implantation, however, the properties of the implanted layer are the desired end. For example, the figure illustrates ion implantation used to modify the transport properties of the bulk material. In irradiation, the important feature is the interaction of the ions with the materials—before the ions come to rest.

Modifying material properties

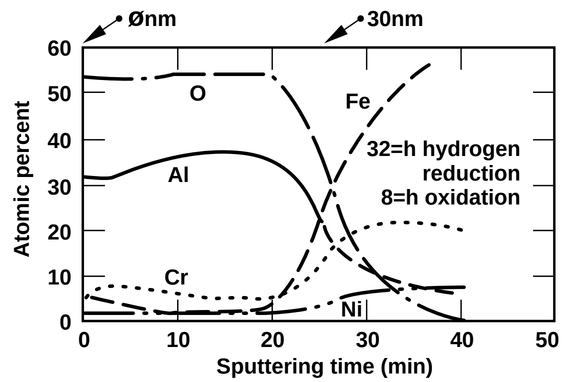
We can modify material properties:

- Electrical
- Corrosion resistance
- Gas–solid interactions
- Friction coefficients
- Wear rates
- Hardness
- Fatigue
- Reflectance and color
- Adhesion of coatings to substrates

Analyzing materials

With high-energy atoms (0–8 MeV), we can provide quantitative, nondestructive characterization of the first 10 μm of any material using Rutherford and non-Rutherford backscattering, particle-induced x-ray emission, forward recoil spectroscopy, and nuclear reaction analysis.

By using one or more of these analysis techniques—and judiciously selecting the ion species and its incident energy—we can tailor the analysis to any element in the periodic table. All four techniques rely on interactions between the ion and the target atom, which occur only when the two particles come within about 0.01 nm—a very small distance compared with the typical interatomic spacing in solids (0.3 nm).



Auger sputter-depth profile showing an Al_2O_3-rich layer on stainless steel resulting from implantation and selective oxidation of aluminum. This layer reduced the permeation of hydrogen isotopes by more than a factor of 20.

Facility resources

- 200-kV ion implanter for ion-beam modifications
- 4-MV accelerator (with beam-rastering system) for characterizing and modifying materials
- Experienced scientific and technical staff

Availability: The Ion-Beam Laboratory is operational now. We are interested in applying high-energy ion beams to the development and processing of materials for many different industries.

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